VI. WORK PRACTICES

(a) Substitution: The most certain and direct method of eliminating the silicosis hazard is to substitute other less toxic material for free silica. [140] In abrasive blasting, where silica sand can be replaced with an abrasive containing less than 1% free silica, such substitution should be considered. A number of such materials are available. These include slag products, metallic shot and grit, garnet, nut shells, cereal husks, and sawdust. [99,100]

(b) Dust suppression: The use of water to allay or prevent formation of dust is as old as the history of industry. Where sand can be used wet, little or no dust is generated. In many sand and mineral handling operations, a moisture content can be determined that will substantially reduce dust while not interfering with the process. The use of water sprays may improve dust conditions considerably [26,140,141]; however, sprays may have a limited use in reducing respirable dust to acceptable levels. [141] Similarly, wetting down piles of dust is helpful as long as the moisture content remains high, but water often does not penetrate far enough into the pile. [141] Wet drilling controls the greatest part of the dust, but enough fine, free silica particulate may be generated so that supplementary control is required. [26,140-142] Thus, although the use of water is encouraged and may be sufficient to solve certain dust problems, it does not necessarily provide a complete solution.

(c) Ventilation: In spite of the wide distribution and acceptance of the Industrial Ventilation manual [97] and the holding of many conferences and training programs, many ventilation systems are still

designed without reference to accepted principles and procedures. This may stem in part from the fact that engineering principles of contamination control are not generally a part of engineering curriculum. Furthermore, even when systems are properly designed, the installation, adjustment, or maintenance may be unsatisfactory.

Visual inspection to ensure that exhaust hoods are in place, intact, open, and connected to the ventilation systems would identify many problems. Plant managers should schedule visual inspection for physical integrity and also mechanical checks to ensure that needed repairs are performed promptly. [97]

In many operations the source of dust is not fixed but depends upon the work being performed. For such dust sources, a movable dust hood often provides the best solution. Such hoods usually require proper placement to make them effective, thus the workers can control their effectiveness. Consequently, they should be so designed to ensure that proper use is not difficult. Improper use of movable hoods generally increases the hazard to the worker and to those around him, therefore, conscientious use of such hoods is required.

(d) Wet drilling and dust collection: Drilling of free silica-bearing rock is a common source of dust which frequently causes silicosis. [16,24-26] Both wet drills and drills with attached dust collectors are available. Even with wet drills and dust collectors, dust concentrations should be monitored and ventilation may be needed. [140] Wet drilling with surface-active agents has improved this method of dust control. Dry drilling without controls should be prohibited.

(e) Labeling and apprisal of hazard: In many dust exposures involving a potential for silicosis, labeling may not be appropriate. The free silica-containing dust is generated from rock, sand, gravel, clay, or other minerals. Shipment of hazardous materials, however, may require labeling. Carloads and bags of silica flour are shipped but users may not be aware of the hazard involved with this material. Likewise, flux-calcined diatomaceous earth contains substantial percentages of cristobalite and tridymite and can generate very hazardous dust. Labels for such materials should be provided.

(f) Protective equipment and clothing: Certain operations, such as abrasive blasting in confined spaces, can be performed safely only with respiratory protection. [99,100] Other dusty operations, in maintenance and repair for instance, are carried out intermittently where exhaust ventilation is not feasible. These operations may also require protective respirators.

For extreme hazards, such as in abrasive blasting, the employer must not only supply suitable respirators but must require their conscientious use. For respirators to provide effective protection, the employee must be trained in their use; further, they must fit properly and be properly maintained. [99,100]

Protective clothing has not been widely used for health protection against free silica dust. Experiments in British potteries have demonstrated, however, that dirty work clothes can be a significant source of dust in that industry. [98] Investigators found that cotton and wool clothing tend to retain dust, and that these materials are less satisfactory than others for health protection. They cited also the

importance of design of work clothing; for example, pleats and other design features can cause significant dust retention. Test procedures for evaluating dust retention of clothing have been developed by the British Ceramic Research Association. It is suggested these procedures be used until better ones have been demonstrated. [98]

(g) Dust monitoring: In order to determine the extent of the potential silicosis problem, the need for periodic monitoring of the operations where exposure to free silica is suspected is required. Schedules for the monitoring of respirable free silica dust concentrations are given in Chapter I, Section 7, of this document.

Construction, agriculture, and service occupations have not been regularly investigated for free silica dust hazards. Although results of the few investigations to date have shown that environmental levels are in excess of current standards, they tend to be negative for silicosis. [143,144] Great changes that have occurred in these industries warrant exploratory and epidemiologic studies to more clearly define the silicosis hazard and the development of methods for control of dust exposure.

VII. REFERENCES

1. Pough FH: A Field Guide to Rocks and Minerals, in The Peterson's Field Guide Series, ed 3. Boston, Houghton Mifflin Co, pp 231-34, 1960

2. Dana JD: Mineralogy, ed 17 (revised by CS Hurlbut Jr). New York, John Wiley & Sons Inc, 1967, pp 475-85

3. Statistical Abstract of the United States, 1971, ed 92. US Dept Commerce, Bureau of the Census. New York, Grosset Dunlap, 1971, p 219

4. Trasko VM: Silicosis, a continuing problem. Public Health Rep 73:839-46, 1958

5. Trasko VM: Some facts on the prevalence of silicosis in the United States. Arch Ind Health 14:379-86, 1956

6. Trasko VM: Socioeconomic aspects of the pneumoconioses. Arch Environ Health 9:521-28, 1964

7. Doyle HN, Flinn RH, Dreessen WC: A review of the pneumoconiosis problem in the United States. Am Ind Hyg Assoc J 19:317-23, 1958

8. Hunter D: The Pneumoconioses, in the Diseases of Occupations. Boston, Little, Brown & Co, 1955, pp 848-54

9. Gross P: Pathology of silicosis, in Lanza AJ (ed): The Pneumoconioses. New York, Grune & Stratton, 1963, pp 40-47

10. Zaidi SH: Experimental Pneumoconiosis. Baltimore, The Johns Hopkins Press, 1969, pp 64-106

11. Council on Occupational Health (E Mayer, MD, Chmn): The Pneumoconioses--Diagnosis, evaluation, and management. Arch Env Health 7: 130-71, 1963

12. Milby TH: Pneumoconioses, in Gafafer WM (ed): Occupational Diseases--A Guide to Their Recognition, PHS publication 1097. US Dept Health, Education, and Welfare, Public Health Service, 1964, pp 46-47

13. Pendergrass EP: The Pneumoconiosis Problem--With Emphasis on the Role of the Radiologist. Springfield, Ill, Charles C Thomas Publisher, 1958, pp 23-30

14. Gardner LU: Rapidly developing silicosis, in Kuechle BE (ed): Fourth Saranac Laboratory Symposium on Silicosis, 1939, pp 236-38

15. Sampson HL: Roentgenographic evidences of rapidly developing silicosis, in Kuechle BE (ed): Fourth Saranac Laboratory Symposium on Silicosis, 1939, pp 239-40

16. Higgins E, Lanza AJ, Laney FB, Rice GS: Siliceous Dust in Relation to Pulmonary Disease Among Miners in the Joplin District, Missouri, bulletin No 132. US Dept Interior, Bureau of Mines, 1917, 116 pp

17. Russell AE, Britten RH, Thompson LR, Bloomfield JJ: The Health of Workers in Dusty Trades--II. Exposure to Siliceous Dust (Granite Industry), Public Health bulletin No 187. US Treasury Dept, Public Health Service, 1929

18. Lanza AJ, Higgins E: Pulmonary Disease Among Miners in the Joplin District, Missouri and Its Relation to Rock Dust in the Mines--A Preliminary Report, technical paper 105. US Dept Interior, Bureau of Mines, 1915, 48 pp

19. Hamlin LE: Chest conditions simulating silicosis. Ind Med 15:376-81, 1946

20. Gloyne SR: Pathology, in Lanza AJ (ed): Silicosis and Asbestosis. New York, Oxford University Press, 1938, pp 198-256

21. Heppleston AG: The pathological anatomy of simple pneumokoniosis in coal workers. J Pathol Bacteriol 66:235-46, 1953

22. Naeye RL, Dellinger WS: Lung disease in Appalachian soft-coal miners. Am J Pathol 58:557-64, 1970

23. ILO U/C International Classification of Radiographs of Pneumoconioses 1971--Occupational Safety and Health Series 22 (rev). Geneva, International Labour Office, 1972, 37 pp

24. Harrington D, Lanza AJ: Miners' Consumption in the Mines of Butte, Montana-- Preliminary Report of an Investigation Made in the Years 1916-1919, technical paper 260. US Dept Interior, Bureau of Mines, 1921, 19 pp

25. Dreessen WC, Page RT, Hough JW, Trasko VM, Jones JL, Franks RW: Health and Working Environment of Nonferrous Metal Mine Workers, Public Health bulletin No 277. Federal Security Agency, US Public Health Service, 1942

26. Flinn RH, Brinton HP, Doyle HN, Cralley LJ, Harris RL Jr, Westfield J, Bird JH, Berger LB: Silicosis in the Metal Mining Industry--A Revaluation 1958-1961, PHS publication No 1076. US Dept Health, Education, and Welfare, Public Health Service and Dept Interior, Bureau of Mines, 1963, 238 pp

27. Renes LE, Heimann H, Brinton HP: Health of Ferrous Foundrymen in Illinois, PHS publication No 31. Federal Security Agency, US Public Health Service and Illinois Dept of Public Health, 1950, 130 pp

28. McConnell WJ, Fehnel JW: Health hazards in the foundry industry. J Ind Hyg 16:227-51, 1934

29. Flinn RH, Dreessen WC, Edwards TI, Riley EC, Bloomfield JJ, Sayers RR, Cadden JF, Rothman SC: Silicosis and Lead Poisoning Among Pottery Workers. Public Health bulletin No 244. US Treasury Dept, Public Health Service, 1939

30. Rajhans GS, Budlovsky J: Dust conditions in brick plants of Ontario. Am Ind Hyg Assoc 33:258-68, 1972

31. Keatinge GF, Potter NM: Health and environmental conditions in brickworks. Br J Ind Med 1:31-44, 1949

32. Fulton WB, Butters FE, Dooley AE, Koppenhaver FB, Matthews JL, Kirk RM: A study of silicosis in the silica brick industry. Commonwealth of Pennsylvania, Dept of Health, Bureau of Industrial Hygiene, Harrisburg, 1941, 60 pp

33. Russell AE: The Health of Workers in Dusty Trades--VII. Restudy of a Group of Granite Workers, Public Health bulletin No 269. Federal Security Agency, US Public Health Service, 1941

34. Hosey AD, Ashe HB, Trasko VM: Control of Silicosis in Vermont Granite Industry--Progress report, Public Health publication 557. US Dept Health, Education, and Welfare, Public Health Service, 1957 65 pp

35. Ashe HB, Bergstrom DE: Twenty-six years' experience with dust control in the Vermont granite industry. Ind Med Surg 33:973-78 1964

36. Ashe HB: Silicosis and dust control--Vermont's granite industry. Public Health Rep 70: 983-85, 1955

37. Theriault GP, Burgess WA, DiBerardinis LJ, Peters JM: Dust exposure in the Vermont granite sheds. Arch Environ Health 28:12-17, 1974

38. Theriault GP, Peters JM, Fine LJ: Pulmonary function in granite shed workers of Vermont. Arch Env Health 28:18-22, 1974

39. Theriault GP, Peters JM, Johnson WM: Pulmonary function and roentgenographic changes in granite dust exposure. Arch Env Health 28:23-27, 1974

40. Cares JW, Goldin WA, Lynch JJ, Burgess AS: The determination of quartz in airborne respirable granite dust by infrared spectrophotometry. Am Ind Hyg Assoc J 34:298-305, 1973

41. Kory RC, Callahan R, Boren HG, Syner JC: The Veterans Administration-Army cooperative study of pulmonary function--I. Clinical spirometry in normal men. Am J Med 30:243-58, 1961

42. UICC/Cincinnati classification of the radiographic appearances of pneumoconioses--A cooperative study by the UICC Committee. Chest 58:57-67, 1970

43. Vigliani EC, Mottura G: Diatomaceous earth silicosis. Br J Ind Med 5:148-60, 1948

44. Cooper WC, Cralley LJ: Pneumoconiosis in diatomite mining and processing, Public Health Service publication No 601. US Dept Health, Education, and Welfare, Public Health Service, Occupational Health Program, 1958, 96 pp

45. Cralley LJ, Cooper WC, Caplan PE: A ten-year epidemiologic follow-up of workers in the diatomite industry in the United States. Proceedings of the Fifteenth International Congress on Occupational Health, Vienna, 1966, pp 595-601

46. Cooper WC: Roentgenographic followup of workers in the diatomite industry. Presented at the American Industrial Hygiene Association Conference, Detroit, May 14, 1970

47. Legge RT, Rosencrantz E: Observations and studies on silicosis by diatomaceous silica. Am J Public Health 22:1055-60, 1932

48. Smart RH, Anderson WM: Pneumoconiosis due to diatomaceous earth--Clinical and X-ray aspects. Ind Med Surg 21: 509-18, 1952

49. King EJ, Mohanty GP, Harrison CV, Nagelschmidt G: The action of different forms of pure silica on the lungs of rats. Br J Ind Med 10:9-17, 1953

50. Gardner LU: Studies on experimental pneumonokoniosis--VII. Inhalation of quartz dust. J Ind Hyg 14: 18-38, 1932

51. Wagner WD, Fraser DA, Wright PG, Dobrogorski OJ, Stokinger HE: Experimental evaluation of the threshold limit of cristobalite-calcined diatomaceous earth. Am Ind Hyg Assoc J 29:211-21, 1968

52. Neymann N: Nachweis des Eindringens elektrisch unipolar aufgeladenen Aerosols in das Lungengewebe bei Rauminhalation, in Jotten KW, Klosterkotter W, Pfefferkorn G: Die Staublungener-krankungen. Darmstadt, Verlag von Dr Dietrich Steinkopff, 1954, pp 354-60

53. Gardner LU: Etiology of pneumoconiosis. JAMA 111:1925-36, 1938

54. Brieger H, Gross P: On the theory of silicosis--I. Coesite. Arch Env Health 13:38-43, 1966

55. Goldstein B, Webster I: Intratracheal injection into rats of size-graded silica particles. Br J Ind Med 23:71-74, 1966

56. King EJ, Mohanty GP, Harrison CV, Nagelschmidt G: The action of flint of variable size injected at constant weight and constant surface into the lungs of rats. Br J Ind Med 10:76-92, 1953

57. Marks J: The neutralization of silica toxicity in vitro. Br J Ind Med 14:81-84, 1957

58. Vigliani EC, Pervis B, Monaco LA: A study of the action of quartz particles in vitro, in Davies CN (ed): Inhaled Particles and Vapours--Proceedings of an International Symposium Organized by the British Occupational Hygiene Society, Oxford, 29 March-1 April, 1960. New York, Pergamon Press, 1961, pp 348-55

59. Heppleston AG, Styles JA: Activity of a macrophage factor in collagen formation by silica. Nature 214:521-22, 1967

60. Heppleston AG: The fibrogenic action of silica. Br Med Bull 25:282-87, 1969

61. Vigliani EC: [Biochemical and biophysical study of hyaline tissues in silicosis.] Zbl Arbeitsmed 6:253-55, 1956 (Ger)

62. Pervis B, Ghislandi E: [Biologic and chemical studies on the hyalin of silicosis--III. Identification of a protein fraction having the chemical characteristics of beta-globulin.] Med Lav 47:460-64, 1956 (It)

63. Allison AC, Harington JS, Birbeck M: An examination of the cytotoxic effects of silica on macrophages. J Exp Med 124:141-53, 1966

64. Burrell R, Anderson M: The induction of fibrogenesis by silica-treated alveolar macrophages. Env Res 6:389-94, 1973

65. Zaidi SH: Pathology of Experimental Silicosis, in Experimental Pneumoconiosis. Baltimore, The Johns Hopkins Press, 1969, pp 64-93

66. Kettle EH: The interstitial reactions caused by various dusts and their influence on tuberculous infections. J Pathol 35:395-405, 1932

67. Gross P, Westrick ML, McNerney JM: Experimental silicosis--The inhibitory effect of iron. Dis Chest 37:35-41, 1960

68. Denny JJ, Robson WD, Irwin DA: The prevention of silicosis by metallic aluminum--I. A preliminary report. Can Med Assoc J 37:1-11, 1937

69. Tabershaw IR, Tebbens BD: The use of aluminum in silicosis control. Ind Med 14: 709-11, 1945

70. Crombie DW, Blaisdell JL, MacPherson G: The treatment of silicosis by aluminum powder. Can Med Assoc J 50: 318-28, 1944

71. Gardner LU, Dworski M, Delahant AB: Aluminum therapy in silicosis. J Ind Hyg Toxicol 26: 211-23, 1944

72. Rauschenbach CW, Johns DR, Larrabee JF, Hammar LM, Poracky BF: Silicosis study and management in the Calumet industrial area. Ind Med 17: 1-6, 1948

73. Schlipkoter HW, Brockhaus A: Polyvinylpyridine and experimental silicosis. Ger Med Monthly 8:270-74, 1960

74. Schlipkoter HW, Hilscher W, Pott F, Beck EG: Investigations on the aetiology of coal workers' pneumoconiosis with the use of PVN-oxide, in Walton WH (ed): Inhaled Particles III--Proceedings of an International Symposium Organized by the British Occupational Hygiene Society in London, 14-23 September, 1970. Old Woking Surrey, Unwin Bros Ltd, The Gresham Press, 1971, pp 379-90

75. Merewether ERA: The risk of silicosis in sand-blasters. Tubercle 17:385-91, 1936

76. Ziskind M, Weill H, Anderson AE, Samini B, Neilson A, Waggenspack C: Silicosis in shipyard sandblasters, paper no 8 in preprints of conference papers. International Shipyard Health Conference, University of Southern California School of Medicine, Los Angeles, December 13-15, 1973, pp XIV-1 to XIV-4

77. Factories Act 1937 and 1948--Blasting (Castings and Other Articles) Special Regulations, 1949 (SI 1949, no 2225). London, Ministry of Labour and National Service, Factory Department, 1951, pp 4331-35

78. Ayer HE, Sutton GW, Davis IR: Size-selective gravimetric sampling in dusty industries. Am Ind Hyg Assoc J 29:336-42, 1968

79. Ayer HE: The proposed ACGIH mass limits for quartz--Review and evaluation. Am Ind Hyg Assoc J 30:117-25, 1969

80. Drinker P, Hatch T: Industrial Dust--Hygienic Significance, Measurement, and Control, ed 2. New York, McGraw-Hill Book Company Inc, 1954, pp 141-44

81. DeGueldre G: Dust Sampling in Mines, Occupational Safety and Health Series No 9. Geneva, International Labour Office, 1967, 88 pp

82. Aerosol Technology Committee (HJ Ettinger, Chairman): Guide for Respirable Mass Sampling. Am Ind Hyg Assoc J 31:133-37, 1970

83. Morrow PE: Evaluation of inhalation hazards based upon the respirable dust concept and the philosophy and application of selective sampling. Ind Hyg J 25:213-36, 1964

84. Hatch TF, Gross P: Pulmonary deposition and retention of inhaled aerosols. New York, Academic Press, 1964, 192 pp

85. Kitto PH: Methods of dust measurement, in Orenstein AJ (ed): Pneumoconiosis--Proceedings of the International Conference, Johannesburg, 9-24 September 1959. Boston, Little, Brown & Co, 1960, pp 13-20

86. Owens JS: Suspended impurity in the air. Proc Roy Soc A 101:18-37, 1922

87. Greenburg L, Smith GW: A new instrument for sampling aerial dust, Serial 2392. US Dept Interior, Bureau of Mines, Reports of Investigations, 1922, pp 1-3

88. Littlefield JB, Feicht FL, Schrenk HH: Bureau of Mines Midget Impinger for Dust Sampling, No 3360. US Dept Interior, Bureau of Mines, Reports of Investigations, 1937, 4 pp

89. Joint Committee on Uniform Methods for Dust Counting: Appendix F--Uniform Method for Impinger Counting, in Transactions of the Thirty-First Annual Meeting of the American Conference of Governmental Industrial Hygienists, Denver, May 11-13, 1969, pp 204-209

90. Sub-committee on Chemical Methods in Air Analysis (FH Goldman, chmn): II. Report of Sub-committee on chemical methods in air analysis--Sampling and sampling devices. Am J Public Health (suppl) 30:92-98, 1940

91. ACGIH Subcommittee on Standard Methods: Determination of atmospheric concentration of fibrosis-producing and similar dusts. (Proposed standard impinger sampling and counting technic.) in Transactions of the Fifth Annual Meeting of the National Conference of Governmental Industrial Hygienists, 1942

92. McKee SB, Fulwiler RD: Determination of particle size, in Powell CH, Hosey AD (eds): The Industrial Environment, its Evaluation and Control--Syllabus, Public Health Service publication No 614. US Dept Health, Education, and Welfare, Public Health Service, Division of Occupational Health, 1965, pp B-7-1 to B-7-11

93. Silverman L, Billings CE, First MW: Particle Size Analysis in Industrial Hygiene. New York, Academic Press, 1971, 317 pp

94. Sutton GW: Sampling for particulates, in Powell CH, Hosey AD (eds): The Industrial Environment, its Evaluation and Control--Syllabus, Public Health Service publication No 614. US Dept Health, Education, and Welfare, Public Health Service, Bureau of Occupational Safety and Health, 1970, pp B-2-1 to B-2-15

95. American Conference of Governmental Industrial Hygienists: Threshold Limit Values of Air-borne Contaminents (sic) for 1968--Recommended and Intended Values. Adopted at the Thirtieth Annual Meeting of ACGIH, St. Louis, Mo, May 13, 1968

96. Bloor WA, Eardley RE, Dinsdale A: Environmental conditions in sanitary whiteware casting shops. Ann Occ Hyg 14:321-27, 1971

97. Committee on Industrial Ventilation: Industrial Ventilation--A Manual of Recommended Practice, ed 13. Lansing, Mich, American Conference of Governmental Industrial Hygienists, 1974

98. Bloor WA, Dinsdale A: Protective clothing in pottery industry, in Davies CN (ed): Health Conditions in the Ceramic Industry--An International Symposium Organized by the North Staffordshire Medical Institute (JT Arlidge Section of Occupational Health) and the British Occupational Hygiene Society, Stoke-on-Trent, 27-29 March, 1968. New York, Pergamon Press, 1969, pp 145-51

99. Industrial Health and Safety Criteria for Abrasive Blast Cleaning Operations--A report prepared under contract HSM 99-72-83 by Arthur D Little Inc, 1973, pp 19-35

100. Abrasive Blasting Respiratory Protective Practices, HEW publication No (NIOSH) 74-104. (Prepared by A Blair). Cincinnati, Ohio, US Dept Health, Education, and Welfare, HSMHA, National Institute for Occupational Safety and Health, Engineering Laboratories

101. Silica (Quartz), in Elkins HB (ed): Documentation of the Threshold Limit Values for Substances in Workroom Air, ed 3. Cincinnati, Ohio, American Conference of Governmental Industrial Hygienists, 1971, pp 227-230

102. American Conference of Governmental Industrial Hygienists: Proceedings of the Eighth Annual Meeting. Chicago, Ill, April 7-13, 1946

103. American Conference of Governmental Industrial Hygienists: Threshold Limit Values for 1962. Adopted at the Twenty-fourth Annual Meeting of the ACGIH, Washington, DC, May 13-15, 1962

104. American Conference of Governmental Industrial Hygienists: Threshold Limit Values of Airborne Contaminants and Intended Changes adopted by ACGIH for 1970. Cincinnati, Ohio, ACGIH, 1970, p 18

105. Silica (Cristobalite) (above 5%), in Committee on Threshold Limit Values: Documentation of Threshold Limit Values. Cincinnati, Ohio, American Conference of Governmental Industrial Hygienists, 1962, pp 91-92

106. American Conference of Governmental Industrial Hygienists: Transactions of the Thirtieth Annual Meeting of the ACGIH, St Louis, Mo, May 12-14, 1968, pp 191-92

107. American Conference of Governmental Industrial Hygienists: Threshold Limit Values of Airborne Contaminants adopted by ACGIH for 1969 and Intended Changes. Cincinnati, Ohio ACGIH, 1969, p 19

108. American Conference of Governmental Industrial Hygienists: Threshold Limit Values for Chemical Substances and Physical Agents in the Workroom Environment with Intended Changes for 1972. Cincinnati, Ohio, ACGIH, 1972

109. McCord CP, Meek SF, Harrold GC: Tripoli and silicosis. Ind Med 12:373-78, 1943

110. Hatch TF, Kindsvatter VH: Lung retention of quartz dust smaller than one-half micron. J Ind Hyg Tox 29:342-45, 1947

111. Schutz A: The MAK value for quartz fine dust from the aspect of conditions in the surface industry. Staub 31:14-20, 1971

112. Ahlmark A, Gerhardsson G: A simple dust index applicable to various dust-contaminated occupations--A program of action for silicosis prophylaxis, in Walton WH (ed): Inhaled Particles III--Proceedings of an International Symposium Organized by the British Occupational Hygiene Society in London, 14-23 September 1970. Old Woking, Surrey, England, Unwin Bros Ltd, Gresham Press, vol II, pp 997-1005

113. Reno SJ, Ashe HB, Levadie BTH: A comparison of count and respirable mass dust sampling techniques in the granite industry. Presented at the 1966 Annual Meeting of the American Industrial Hygienists Association, Pittsburgh, Pa

114. Sutton GW, Reno SJ: Sampling in Barre, Vermont, granite sheds, draft report. Cincinnati, Ohio, Occupational Health Program, National Center for Urban and Industrial Health, 1967

115. Roach SA, Baier EJ, Ayer HE, Harris RL: Testing compliance with threshold limit values for respirable dusts. Am Ind Hyg Assoc J 28:543-53, 1967

116. Orenstein AJ (ed): Recommendations adopted by the Pneumoconiosis Conference, in Proceedings of the Pneumoconiosis Conference, held at the University of Witwatersrand, Johannesburgh, 9-24 February, 1959. Boston, Little, Brown and Co, 1960, pp 617-21

117. Panel on Evaluation of Exposures to Mineral Dusts (RL Harris Jr, Moderator), in Transactions of the Twenty-eighth Annual Meeting of the American Conference of Governmental Industrial Hygienists. Pittsburgh, Pa, ACGIH, May 15-17, 1966, pp 9-44

118. Talvitie NA: Determination of quartz in presence of silicates using phosphoric acid. Anal Chem 23:623-26, 1951

119. Talvitie NA, Hyslop F: Colorimetric determination of siliceous atmospheric contaminants. Am Ind Hyg Assoc J 19:54-58, 1958

120. Talvitie NA: Determination of free silica--Gravimetric and spectrophotometric procedures applicable to air-borne and settled dust. Am Ind Hyg Assoc J 25:169-78, 1964

121. Sweet DV, Wolowicz FR, Crable JV: Spectrophotometric determination of free silica. Am Ind Hyg Assoc J 34:500-06, 1973

122. Larsen DJ, von Doenhoff LJ, Crable JV: The quantitative determination of quartz in coal dust by infrared spectroscopy. Am Ind Hyg Assoc J 33:367-72, 1972

123. Dixon K, Fretwell TS: The determination of quartz in airborne dust of coal mines and in coal measure minerals by infra-red spectroscopy, Report No SNT/55/68. National Coal Board, South Nottinghamshire Area (Great Britain), Scientific Dept, 1968, 14 pp

124. Determination of free silica (quartz) in ashed respirable coal mine dust by infrared spectroscopy, Standard Method No 19. Pittsburgh, Pa, US Bureau of Mines, 1968

125. Tuddenham WM, Lyon RJP: Infrared techniques in the identification and measurement of minerals. Anal Chem 32:1630-34, 1960

126. Taylor DG, Nenadic CM, Crable JV: Infrared spectra for mineral identification. Am Ind Hyg Assoc J 31:100-08, 1970

127. Gillieson AH, Farrell DM: The determination of quartz in dusts by infrared spectroscopy. Can Spectros 16:21-26, 1971

128. Soda R: Determination of quartz dust in the atmosphere by means of infrared spectroscopy. Bull Natl Inst Ind Health, No 4:29-43, 1960

129. Gade M, Luft KF: Die ultrarotspektroskopische Quarzbestimmung insbesondere von Grubenstauben. Staub 23:353-57, 1963

130. Leroux J, Powers CA: Direct X-ray diffraction quantitative analysis of quartz in industrial dust films deposited on silver membrane filters. Staub 29:26-31, 1969

131. Crosby MT, Hamer PS: The determination of quartz on personal sampler filters by X-ray diffraction. Ann Occup Hyg 14:65-70, 1971

132. Nenadic CM, Crable JV: Application of X-ray diffraction to analytical problems of occupational health. Am Ind Hyg Assoc J 32:529-38, 1971

133. Index (Inorganic) to the Powder Diffraction File 1971, publication PDIs-21i. Swarthmore, Pa, Joint Committee on Powder Diffraction Standards

134. Klug HP, Alexander LE: X-ray Diffraction Procedures for Polycrystalline and Amorphous Materials. New York, John Wiley and Sons Inc, chap 11, pp 586-88, 1954

135. Bumsted HE: Determination of alpha-quartz in the respirable portion of airborne particulates by X-ray diffraction. Am Ind Hyg Assoc J 34:150-58, 1973

136. Knight G, Stefanich W, Ireland G: Laboratory calibration of a technique for determination of respirable quartz in mine air. Am Ind Hyg Assoc J 33:469-75, 1972

137. American Conference of Governmental Industrial Hygienists: Proceedings from round table discussion on analytical techniques for quartz, Cincinnati, Ohio, December 6-7, 1972

138. Physical and Chemical Analysis Branch, Division of Laboratories and Criteria Development: Quartz in coal dust by infrared spectroscopy, in NIOSH Manual of Analytical Methods. Cincinnati, Ohio, US Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, 1974, pp 110-1 to 110-6

139. Physical and Chemical Analysis Branch, Division of Laboratories and Criteria Development: Colorimetric method for free silica, in NIOSH Manual of Analytical Methods. Cincinnati, Ohio, US Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, 1974, pp 106-1 to 106-7

140. Olishifski JB: General methods of control, in Olishifski JB, McElroy FE (eds): Fundamentals of Industrial Hygiene. Chicago, National Safety Council, 1971, pp 439-506

141. Schlick DP, Fannick NL: Coal in the United States--A Review of U.S. Experience, in Key MM, Kerr LE, Bundy M (eds): Pulmonary Reactions to Coal Dust--A Review of US Experience. New York, Academic Press 1971, pp 13-26

142. Hamilton RJ: The Control of Dust in Mining, in Rogan JM (ed): Medicine in the Mining Industries. Philadelphia, FA Davis Company, 1972, pp 128-44

143. Kleinman GD, Cooper WC: Occupational Health of Construction Workers in California. California Dept Public Health, Bureau Occup Health, Oct 1967, 66 pp

144. Ottoboni F, Milby TH: Occupational disease potentials in the heavy equipment operator. Arch Environ Health 15:317-21, 1967

145. Lippmann M: "Respirable" dust sampling, Air Sampling Instruments for Evaluation of Atmospheric Contaminants, ed 4. Cincinnati, Ohio, American Conference of Governmental Industrial Hygienists, 1972, pp G-1 to G-17

146. Physical and Chemical Analysis Branch, Division of Laboratories and Criteria Development: Free silica (quartz, cristobalite, tridymite) in atmospheric dust, in NIOSH Manual of Analytical Methods. Cincinnati, Ohio, US Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, 1974, pp 109-1 to 109-7

147. Talvitie NA, Brewer LW: X-ray diffraction analysis of industrial dust. Am Ind Hyg Assoc J 23:214-21, 1962

148. Bradley AA: The determination of quartz in small samples by an X-ray technique. J Sci Instr 44:287-88, 1967

149. Kaelble EF (ed): Handbook of X-rays for Diffraction, Emission, Absorption and Microscopy. New York, McGraw-Hill Book Company, 1967

150. Leroux J, Davey ABC, Paillard A: Proposed standard methodology for the evaluation of silicosis hazards. Am Ind Hyg Assoc J 34:409-17, 1973